innodisk

Total Solution For
Industrial Flash Storage

SATADOM-SV

3SE4 Series

Customer: _____

Customer Part Number: _____

Innodisk Part Number: _____

Innodisk Model Name: _____

Date: _____

Innodisk Approver	Customer Approver

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Revision History

Revision	Description	Date
V1.0	First Released	Dec., 2021
V1.1	Update Product Photo & Mechanical Drawing	Apr., 2024

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1. Product Overview

1.1 Introduction of InnoDisk SATADOM-SV 3SE4

Innodisk SATADOM-SV 3SE4 is characterized by L3 architecture with Marvell NAND controller and SLC NAND Flash. Innodisk's exclusive L3 architecture is L2 architecture multiplied LDPC (Low Density Parity Check). L2 (Long Life) architecture is a 4K mapping algorithm that reduces WAF and features a real-time wear leveling algorithm to provide excellent performance and prolong lifespan with exceptional reliability.

Innodisk SATADOM-SV 3SE4 is designed for industrial field, and supports several standard features, including TRIM, NCQ, and S.M.A.R.T. In addition, Innodisk's exclusive industrial-oriented firmware provides a flexible customization service, making it perfect for a variety of industrial applications.

The innovative Pin8 uses the SATA connector itself as a power supply to drive the device without external cables. It could be connected directly to the SATA on-board socket on customer's system without additional power cable. Besides, the booting time for operation and the power consumption is less than hard disk drive (HDD), and can work under harsh environment compile with ATA protocol, no additional drives are required, and the SSD can be configured as a boot device or data storage device.

1.2 Product View and Models

Innodisk SATADOM-SV 3SE4 is available in follow capacities within SLC flash ICs.

SATADOM-SV 3SE4 8GB

SATADOM-SV 3SE4 16GB

SATADOM-SV 3SE4 32GB

Figure 1: Innodisk SATADOM-SV 3SE4

1.3 SATA Interface

Innodisk SATADOM-SV 3SE4 supports SATA III interface, and compliant with SATA I and SATA II.

2. Product Specifications

2.1 Capacity and Device Parameters

SATADOM-SV 3SE4 device parameters are shown in Table 1.

Table 1: Device parameters

Capacity	Cylinders	Heads	Sectors	LBA	User Capacity(MB)
8GB	15525	16	63	15649200	7641
16GB	16383	16	63	31277232	15272
32GB	16383	16	63	62533296	30533

2.2 Performance

Burst Transfer Rate: 6.0Gbps

Table 2: Performance

Capacity	8GB	16GB	32GB
Sequential* Read (max.)	375MB/s	520 MB/s	530 MB/s
Sequential* Write (max.)	75MB/s	150 MB/s	260 MB/s
4KB Random** Read (QD32)	23,000 IOPS	26,000 IOPS	32,000 IOPS
4KB Random** Write (QD32)	13,000 IOPS	26,000 IOPS	28,000 IOPS

Note: performance is based on CrystalDiskMark 5.1.2 with file size 1000MB and Queue Depth 32

2.3 Electrical Specifications

2.3.1 Power Requirement

Table 3: Innodisk SATADOM-SV 3SE4 Power Requirement

Item	Symbol	Rating	Unit
Input voltage	V_{IN}	+5V DC +- 5%	V

2.3.2 Power Consumption

Table 4: Power Consumption

Mode	Power Consumption (mA)
Read	147 (rms)
Write	312 (rms)
Idle	98 (rms)
Peak Current*	876(max.)

Target: 32GB SATADOM-SV 3SE4

***To design in Pin7/8 VCC on motherboard, 5V with 1A power supply is requested.**

2.4 Environmental Specifications

2.4.1 Temperature Ranges

Table 5: Temperature range for SATADOM-SV 3SE4

Temperature	Range
Operating	Standard Grade: 0°C to +70°C
	Industrial Grade: -40°C to +85°C
Storage	-55°C to +95°C

2.4.2 Humidity

Relative Humidity: 10-95%, non-condensing

2.4.3 Shock and Vibration

Table 6: Shock/Vibration Testing for SATADOM-SV 3SE4

Reliability	Test Conditions	Reference Standards
Vibration	7 Hz to 2K Hz, 20G, 3 axes	IEC 60068-2-6
Mechanical Shock	Duration: 0.5ms, 1500 G, 3 axes	IEC 60068-2-27

2.4.4 Mean Time between Failures (MTBF)

Table 7 summarizes the MTBF prediction results for various SATADOM-SV 3SE4 configurations. The analysis was performed using a RAM Commander™ failure rate prediction.

- **Failure Rate**: The total number of failures within an item population, divided by the total number of life units expended by that population, during a particular measurement interval under stated condition.

- **Mean Time between Failures (MTBF)**: A basic measure of reliability for repairable items: The mean number of life units during which all parts of the item perform within their specified limits, during a particular measurement interval under stated conditions.

Table 7: SATADOM-SV 3SE4 MTBF

Product	Condition	MTBF (Hours)
Innodisk SATADOM-SV 3SE4	Telcordia SR-332 GB, 25°C	>3,000,000

2.5 CE and FCC Compatibility

SATADOM-SV 3SE4 conforms to CE and FCC requirements.

2.6 RoHS Compliance

SATADOM-SV 3SE4 is fully compliant with RoHS directive.

2.7 Reliability

Table 8: SATADOM-SV 3SE4 TBW

Parameter	Value	
Read Cycles	Unlimited Read Cycles	
Flash endurance	60,000 P/E cycles	
Wear-Leveling Algorithm	Support	
Bad Blocks Management	Support	
Error Correct Code	Support	
TBW* (Total Bytes Written) Unit: TB		
Capacity	**Sequential workload**	**Client workload**
08GB	468.75	312.5
16GB	937.5	625
32GB	1875	1250

* Note:

1. Sequential: Mainly sequential write, tested by Vdbench.
2. Client: Follow JESD218 Test method and JESD219A Workload, tested by ULINK. (The capacity lower than 64GB client workload is not specified in JEDEC219A, the values are estimated.)
3. Based on out-of-box performance.

2.8 Transfer Mode

SATADOM-SV 3SE4 support following transfer mode:

Serial ATA I 1.5Gbps

Serial ATA II 3.0Gbps

Serial ATA III 6.0Gbps

2.9 Pin Assignment

Innodisk SATADOM-SV 3SE4 uses a standard SATA pin-out. See Table 9 for SATADOM-SV 3SE4 pin assignment.

Table 9: Innodisk SATADOM-SV 3SE4 Pin Assignment

Name	Type	Description
Pin 0	GND	Shielding
Pin 1	GND	Shielding
Pin 2	A+	Differential signal to A
Pin 3	A-	Differential signal to A-
Pin 4	GND	Shielding
Pin 5	B-	Differential signal to B-
Pin 6	B+	Differential signal to B
Pin 7	GND/ Vcc*	Shielding/ +5V Power*
Pin 8	VCC	+5V Power

*** SATADOM-SV 3SE4 default power supply through pin 8 or extra power cable.**

Pin 7 power supply as an optional function with separated PN end of B.

2.10 Mechanical Dimensions

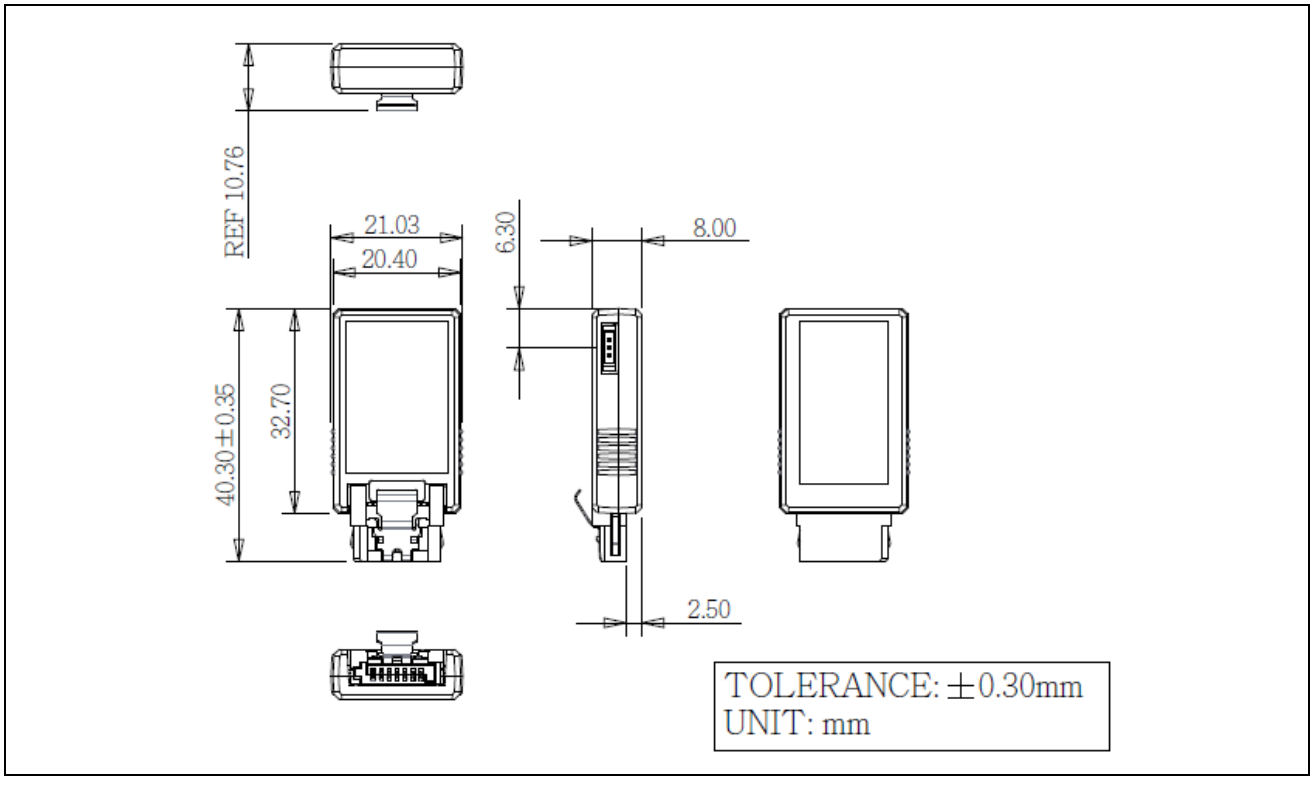

Figure 2: Innodisk SATADOM-SV 3SE4 mechanical diagram

2.11 Assembly Weight

An Innodisk SATADOM-SV 3SE4 within flash ICs, 32GB's weight is 7 grams approximately.

2.12 Seek Time

Innodisk SATADOM-SV 3SE4 is not a magnetic rotating design. There is no seek or rotational latency required.

2.13 Hot Plug

The SSD support hot plug function and can be removed or plugged-in during operation. User has to avoid hot plugging the SSD which is configured as boot device and installed operation system.

Surprise hot plug : The insertion of a SATA device into a backplane (combine signal and power) that has power present. The device powers up and initiates an OOB sequence.

Surprise hot removal: The removal of a SATA device from a powered backplane, without first being placed in a quiescent state.

2.14 NAND Flash Memory

Innodisk SATADOM-SV 3SE4 uses Single Level Cell (SLC) NAND flash memory, which is non-volatility, high reliability and high speed memory storage. Each cell stores 2 bits or holds four states per cell. Read or Write data to flash memory for SSD is control by microprocessor.

3. Theory of Operation

3.1 Overview

Figure 3 shows the operation of Innodisk SATADOM-SV 3SE4 from the system level, including the major hardware blocks.

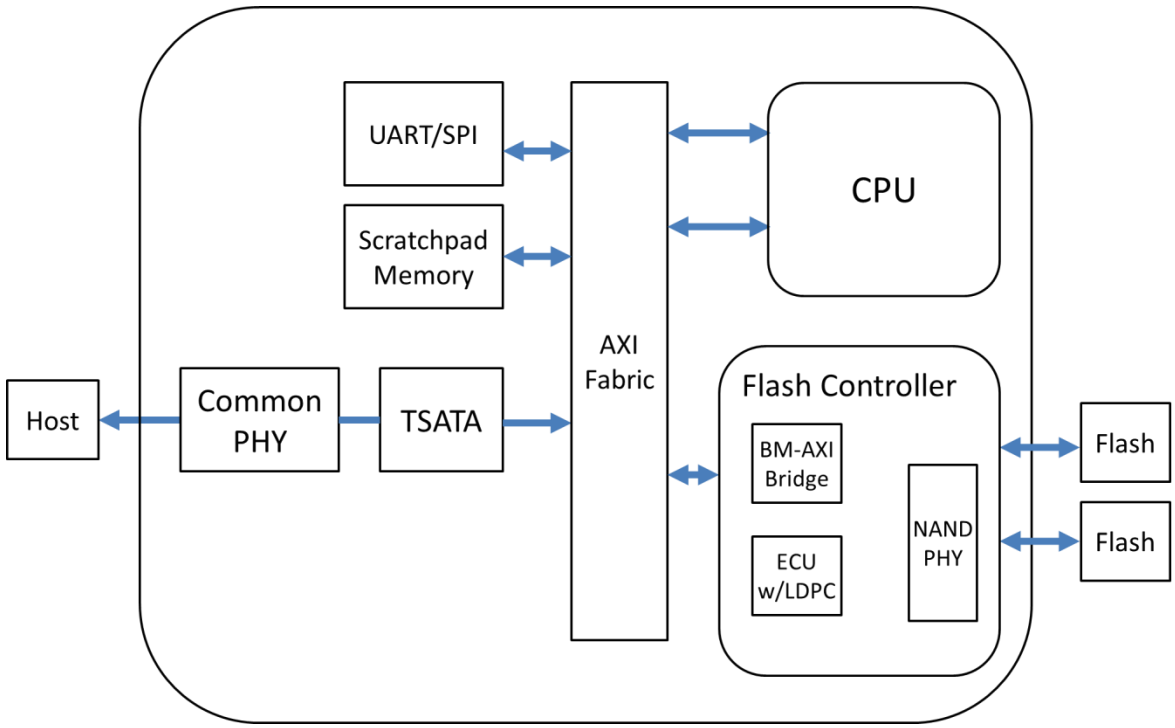

Figure 3: Innodisk SATADOM-SV 3SE4 Block Diagram

Innodisk SATADOM-SV 3SE4 integrates a SATA III controller and NAND flash memories. Communication with the host occurs through the host interface, using the standard ATA protocol. Communication with the flash device(s) occurs through the flash interface.

3.2 SATA III Controller

Innodisk SATADOM-SV 3SE4 is designed with 88NV1120, a SATA III 6.0Gbps (Gen. 3) controller. The Serial ATA physical, link and transport layers are compliant with Serial ATA Gen 1, Gen 2 and Gen 3 specification (Gen 3 supports 1.5Gbps/3.0Gbps/6.0Gbps data rate). The controller has 2 channels for flash interface.

3.3 Error Detection and Correction

Innodisk SATADOM-SV 3SE4 is designed with hardware LDPC ECC engine with hard-decision and soft-decision decoding. Low-density parity-check (LDPC) codes have excellent error correcting performance close to the Shannon limit when decoded with the belief-propagation (BP) algorithm using soft-decision information.

3.4 Wear-Leveling

Flash memory can be erased within a limited number of times. This number is called the ***erase cycle limit*** or ***write endurance limit*** and is defined by the flash array vendor. The erase cycle limit applies to each individual erase block in the flash device.

Innodisk SATADOM-SV 3SE4 uses a static wear-leveling algorithm to ensure that consecutive writes of a specific sector are not written physically to the same page/block in the flash. This spreads flash media usage evenly across all pages, thereby extending flash lifetime.

3.5 Bad Blocks Management

Bad Blocks are blocks that contain one or more invalid bits whose reliability are not guaranteed. The Bad Blocks may be presented while the SSD is shipped, or may develop during the life time of the SSD. When the Bad Blocks is detected, it will be flagged, and not be used anymore. The SSD implement Bad Blocks management, Bad Blocks replacement, Error Correct Code to avoid data error occurred. The functions will be enabled automatically to transfer data from Bad Blocks to spare blocks, and correct error bit.

3.6 iData Guard

Innodisk's power cycling management is a comprehensive data protection mechanism that functions before and after a sudden power outage to SSD. Low-power detection terminates data writing before an abnormal power-off, while table-remapping after power-on deletes corrupt data and maintains data integrity. Innodisk's power cycling provides effective power cycling management, preventing data stored in flash from degrading with use.

3.7 Garbage Collection

Garbage collection is used to maintain data consistency and perform continual data cleansing on SSDs. It runs as a background process, freeing up valuable controller resources while sorting good data into available blocks, and deleting bad blocks. It also significantly reduces write operations to the drive, thereby increasing the SSD's speed and lifespan.

3.8 TRIM

The TRIM command is designed to enable the operating system to notify the SSD which pages no longer contain valid data due to erases either by the user or operating system itself. During a delete operation, the OS will mark the sectors as free for new data and send a TRIM command to the SSD to mark them as not containing valid data. After that the SSD knows not to preserve the contents of the block when writing a page, resulting in less write amplification with fewer writes to the flash, higher write speed, and increased drive life.

4. Installation Requirements

4.1 SATADOM-SV 3SE4 Pin Directions

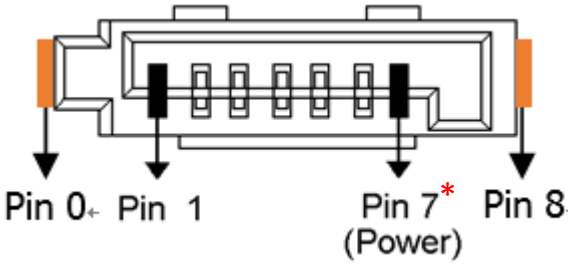

Figure 4: Signal Segment and Power Segment

*** SATADOM-SV 3SE4 default power supply through pin 8 or extra power cable.**

Pin 7 power supply as an optional function with separate PN end of B.

4.2 Electrical Connections for SATADOM-SV 3SE4

A Serial ATA device may be either directly connected to a host or connected to a host through a cable. For connection via cable, the cable should be no longer than 1 meter. The SATA interface has a separate connector for the power supply. Please refer to the pin description for further details.

4.3 Device Drive

No additional device drives are required. The Innodisk SATADOM-SV 3SE4 can be configured as a boot device.

4.4 Power supply for SATDOM

4.4.1 Power cable

A power cable is shipped with each SATADOM product, which has standard 4 pins power connector and special 3 pins power connector for SATADOM. The male and female power connector of SATADOM have foolproof design to avoid misconnection, please check it before power on. Innodisk also can customize the power connector for different host power socket design.

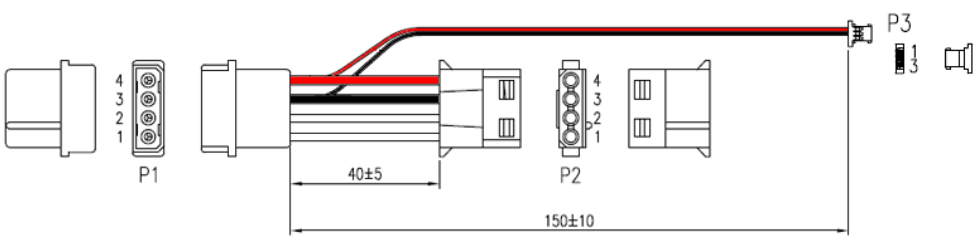

Figure 5: Standard power cable

4.4.2 Pin8 and Pin7 VCC

Innodisk's SATADOM SSDs provide an elegant, compact option for SSD storage in embedded systems, industrial PCs and server motherboards with their small form factor that connects directly to the SATA connector on the motherboard. This simplified SSD design not only frees up a precious drive bay for other storage options but eliminates messy, obtrusive SATA data cabling. Innodisk's patented Pin7 and Pin 8 SATA Power technologies take the cable-less concept to the next step by also eliminating the need for power cables for a 100% cable-less, shock resistant, space saving plug-and-play storage solution that optimizes airflow and makes the best use of limited board space in embedded and rackmount server systems.

SATADOM-SV 3SE4 series with Pin8/Pin7 VCC, it is defined Pin8/Pin7 as VCC on the SATA connector. Thus the power would come from SATA connector Pin8/Pin7 VCC. Customers DO NOT have to use the power cable for power supply. Such a cable-less design of SATADOM-SV 3SE4 series with Pin8/Pin7 VCC brings more convenience to customers' system. The followings are the points customers have to be careful of while designing in SATADOM-SV 3SE4 series with Pin8/Pin7 VCC.

When customers use SATADOM with Pin8/Pin7 VCC and the host SATA socket does not have power on Pin8/Pin7, external power must be provided to the SATADOM from the 3pin connector on the side.To have the advantages of SATADOM-SV 3SE4 series with Pin8/Pin7 VCC, and to avoid any potential damage on customer's board designed with VCC power supply. Innodisk suggests that customers MUST design their board with a fuse which should be designed before the SATA socket Pin8/Pin7 VCC. In other words, customers are suggested NOT TO layout 5V VCC to SATA socket on board directly. A circuit diagram example to explain this is shown as below.

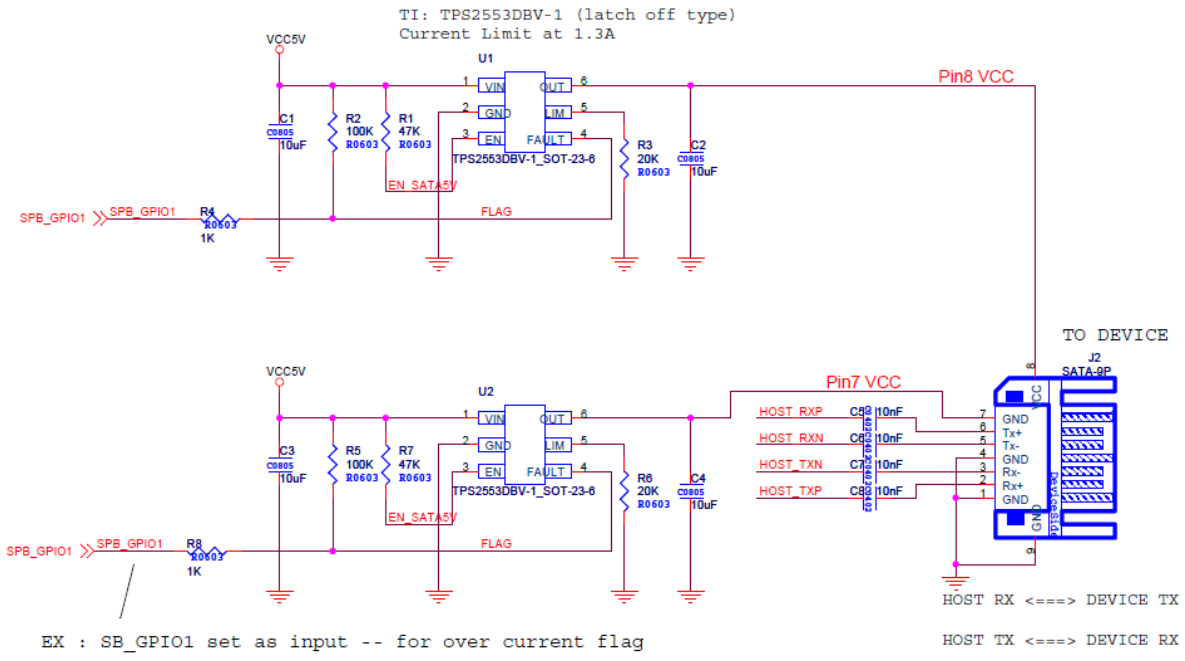

Figure 6: Pin 8 / Pin 7 host design in reference circuit

5. Part Number Rule

CODE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
	D	**E**	**S**	**S**	**V**	**-**	**3**	**2**	**G**	**M**	**4**	**1**	**S**	**C**	**A**	**D**	**B**	**A**	**X**	**X**	**X**

Definition	
Code 1st (Disk)	**Code 14th (Operation Temperature)**
D: Disk	C: Standard Grade (0℃~ +70℃)
Code 2nd (Feature set)	W: Industrial Grade (-40℃~ +85℃)
E: Embedded series	**Code 15th (Internal control)**
Code 3rd ~5th (Form factor)	A~Z: BGA PCB version.
SSV: SATADOM-SV	**Code 16th (Channel of data transfer)**
Code 7th ~9th (Capacity)	D: Dual Channel
08G:8GB / 16G:16GB / 32G:32GB	
Code 10th ~12th (Controller)	**Code 17th (Flash Type)**
M41: 3SE4 Series	B: Toshiba SLC
	Code 18th (pin7 type)
Code 13th (Flash mode)	A: Pin8 version& Power cable version
S: Toshiba 24nm, Sync	B: Pin8 & Pin7 version
	Code 19th~21st (Customize code)